From this analysis we see that *B. orientalis*, although intermediate between *B. igneus* and *B. pachypus*, is on the whole nearer the latter. So far as we know, the enormous area separating the habitats of *B. igneus** and *B. orientalis* does not seem to be tenanted by any form of the genus *Bombinator* or any other Discoglossoid.

CAUDATA.

19. *Salamandrella Keyserlingii.*

Dybowski, Verh. zool.-bot. Ges. Wien, 1870, p. 237, pl. vii.
Isodactylium Schrenckii, Strauch, Salam. p. 56, pl. ii. fig. 1.

Lake Baikal, Schilka and Ussuri Rivers. Specimens from Chabarowka are in Hr. Dörries's collection.

20. *Geomolge Fischeri.*

Bouleng. P. Z. S. 1886, p. 416, pl. xxxix. fig. 2.

The only specimens known of this very remarkable Salamandroid are the two types obtained by Hr. Dörries at Chabarowka.

XVIII.—*Notes on some Heliozoa.* By M. EUG. PENARD †.

THE Heliozoa are most frequently met with in the fresh water of pools, peat-mosses, and brooks. Although these organisms were observed during the last century (Joblot, O. F. Müller, Eichhorn) it is only within about thirty years that they have been well known. Classed for a long time with the Infusoria, they were grouped by Häckel in 1866 into a special subclass. By their particularly elegant forms and their whole organization the Heliozoa, by showing us to what degree of differentiation a simple Rhizopod may attain, fully deserve the interest which has attached to them, and it is to them that I would for a moment call attention.

These animals are in reality only Rhizopods; but while in

* Not recorded east of the Ural. *B. pachypus*, which inhabits the plain in the west of Europe, appears to be exclusively a hill-form in the east; it is not known from Russia.

† Communicated to the Société de Physique et d'Histoire Naturelle de Genève, 3rd October, 1889; Bibl. Univ., 'Archives des Sciences Physiques et Naturelles,' tome xxii. pp. 523–539.

their near Amœbiform relatives the tendency towards perfection is in general directed to the acquisition of a rigid capsule open at one point to allow the passage of the pseudopodia, as is seen in the carapaces of the *Difflugiæ*, *Arcellæ*, *Euglyphæ*, &c., in the Heliozoa we may say that this tendency has led towards the possession of a coat of mail surrounding the whole body, and from which issue in all directions long radiating pseudopodia.

The external envelope, however, in some of them still consists only of a thick layer of hyaline plasma, which, in the Actinophrydians, is marked by large vacuoles; in others (*Lithocolla*) this hyaline layer is covered with stones derived from the medium in which the animal lives; in the *Clathrulinæ* we find an elegant solid trellis-work, formed throughout by the individual and pierced on all sides; but in the majority of the species we meet with a true coat of mail, the mobile elements of which, siliceous scales and spicules, are buried in the external mucilaginous layer which has just been mentioned.

The pseudopodia are always remarkable for their fineness, their rigidity, and their length; in this respect they differ at the first glance from those of the Amœban Rhizopods, whether naked or testaceous, although in some of the latter (*Euglypha*, *Trinema*, *Cyphoderia*, &c.) they may also be very long, very fine, and comparatively rigid.

All the true Heliozoa have at least one nucleus, sometimes two, or even more, but in general unity is the rule; *Actinosphærium Eichhornii*, on the other hand, constantly contains a considerable number, up to one hundred or more.

This nucleus likewise always possesses what has been called a vesicular structure, which also occurs among the Amœbæ; passing from the centre towards the periphery, it consists of a voluminous central body, surrounded by a thicker or thinner zone of hyaline substance (the nuclear fluid), liquid in appearance, and in its turn bounded by a true nuclear membrane, rather thick in the Actinophrydians and very delicate in the other Heliozoa. As to the central mass of the nucleus, generally regarded as the nucleolus, it is most frequently simple; but sometimes we find it divided into several fragments immersed in the nuclear fluid.

The nucleus, taken as a whole, is central in some species, excentric in the majority, but it always belongs nevertheless to that part of the plasma which has been called endosarc, to distinguish it from a generally less homogeneous, more granular zone, which, however, is often absent or impossible to distinguish from the former, and to which the name of ectosarc is given.

In this brief general description of the Heliozoa we may mention lastly the more or less numerous vacuoles which appear and disappear irregularly in the mass of the plasma, and the more differentiated contractile vesicle, which probably is not deficient in any Heliozoon. This vesicle presents phenomena of diastole and systole, slowly increasing in volume and then suddenly contracting. Frequently we only see one of them; but I have remarked that even in the species which normally have only a single one we may always expect to find individuals which have several; thus the number of the contractile vesicles, in my opinion, is only of very secondary value in the determination of species.

I wish at present to treat only of some points in the anatomy of the Heliozoa and of some still imperfectly known phenomena in the life of these animals. In fact at Wiesbaden, a locality which has proved to be very rich both in species and individuals, I have had the opportunity of studying most of the forms which have hitherto been described, and my observations have been made upon a number of individuals so considerable that I have been able to arrive at conclusions deserving of some interest.

In the first place I shall say a few words upon the protective covering of certain typical forms. In *Actinophrys sol* it is the vacuolized ectosarc which performs the part of the envelope; the body is surrounded by a layer of vesicles, which, by their mutual pressure, often form a regular pattern of cells with the walls formed simply of hyaline plasma. In *Actinosphærium Eichhorni* the case is again the same, but the layer of cells is more regular, so that, under a low power, the ectosarc appears like a wide clear band traversed by radiating striæ, these striæ only representing the walls of the cells.

If now we pass at once from the Actinophrydians to the great family of the Acanthocystidæ we find a very different structure. The central mass of the body is still surrounded by a mucilaginous envelope, but without vacuoles; and this envelope itself seems to be doubled, the narrow inner zone remaining homogeneous and clear, the outer one containing a considerable number of small tangential scales, which are sufficiently close together to lead to the belief in a continuous membrane, or may even overlie one another; besides these tangential scales we find, immersed in this external zone of the envelope, the bases of the radial spicules to which we shall refer hereafter.

Now most authors, who, it must be said, seem to have the idea only of a continuous membrane where there are in reality only free scales plunged in a mucilage, have regarded either this membrane or the narrow clear zone of plasma which lies immediately within it as a sort of exudation of the central plasma of no particular importance; and as, on the other hand, this central plasma is really often seen split into two concentric zones, the two latter have, in the Acanthocystidæ, been denominated the ecto- and endosarc.

In my opinion we have here a confusion. In fact I have been able to ascertain that the skeletal mucilaginous zone is perfectly active, and behaves physiologically—for example, during the capture of prey—like the vacuolized ectosarc of *Actinophrys*. I should therefore be inclined to regard it as the true ectosarc. It is true that this opinion is open to dispute; but as I have referred to it at greater length elsewhere *, I shall not dwell upon it here; moreover the sequel of this communication will contain some explanations of this point.

Let us return to the skeleton properly so called, to the siliceous spicules, and take as an example one of the largest species, *Acanthocystis turfacea*, Carter, which is best fitted for observation.

The skeleton of a *typical* and adult *Acanthocystis turfacea* is composed of siliceous elements of three forms:—

a. Of thick, very short, tangential scales, giving rise by their combination one after the other to the appearance of a continuous membrane;

b. Of large radial spicules, bifurcate at the apex, and terminated like nail-heads at the base, nearly equalling in length the diameter of the animal itself; and

c. Of smaller radial spicules, exceedingly fine, widely bifurcated at the apex, intercalated among the large spicules.

The structure of these spicules is not well known, and therefore I may venture to dwell upon them for a moment. Having had the opportunity of observing a great number of individuals of different ages, I have in the first place ascertained certain points, which may be summed up as follows:—

a. The long spicules of *Acanthocystis turfacea* are thicker, more definite, and longer in proportion as the animal is older.

b. In the young we see only the stem of the spicule, which is fine and not well defined; the nail-head of the base and the fork at the apex are not visible (do not exist?).

* 'Archives de Biologie,' tome ix. (1889).

c. The chief body of the spicule is already perfectly distinct when the base and the head are still scarcely so.

d. In the adult the base and the fork at the apex always remain more indistinct than the body of the stem; the fork, of a dull blue colour, is, as it were, implanted upon the stem, which seems as if truncated behind the bifurcation.

e. The body of the spicule perfectly resists concentrated sulphuric acid, as also a red heat, while the head and the base disappear; but after the action of these reagents the spicule is then traversed in this species by a central line, which is brownish by refraction and seems to show that it is hollow, as indeed Greeff has already stated.

f. The spicule, especially when young, seems to be covered with a very fine mucilaginous varnish. This may be inferred from the appearances in the living animal, then after simple desiccation, and finally in glycerine, or from the effects produced by the action of an acid.

From these observations, checked by others made upon three different species (*Acanthocystis aculeata*, *erinaceus*, and *albida*) which have given me the same results, I think it is permissible to draw the following conclusion:—" The spicules of the *Acanthocystides* are clothed, at least during the time of their growth, with a mucilaginous varnish, within which they are formed. Their growth takes place at the same time at the base and at the apex."

I may add that, having found in January last in one of my bottles a great quantity of young individuals belonging to *Acanthocystis albida*, sp. nov., and examined them from time to time, at each observation I found their radial spicules more vigorous, so that in three months their thickness and length were nearly double what they were at the first observation; later on these animals remained stationary and died in water which no longer furnished them with food. As there is scarcely any doubt that I had constantly to do with the same generation, we must infer from this that these animals took three months at least to arrive at the adult state, and that their life is consequently tolerably long.

Another point in the physiology of the Heliozoa which is still obscure regards the movements of the animal, and leads me to say a few words on the pseudopodia.

Here again we find a well-marked difference between the Actinophrydians, that is to say the genera *Actinophrys* and *Actinosphærium* on the one hand, and the rest of the Heliozoa on the other. The pseudopodia of *Actinophrys* consist of a hyaline axial thread, which, however, is rarely visible, covered by a layer of greyish plasma, rather thick at the base and very fine at the apex of the pseudopodium, and in which regular but very slow movements of granules have been recognized. The axial thread, which may be seen even in the interior of the inner plasma of the animal, where it abuts against the nuclear membrane, presents the curious phenomenon that under certain circumstances it may completely dissolve and disappear from sight, to reappear an instant afterwards. Hitherto we have not succeeded in explaining this phenomenon; some authors have imagined an actual retreat, in which the thread would roll up upon itself, but this attempt at an explanation cannot be sustained, for besides that one would easily see the thread in the rolled-up state, I have several times in compressed specimens witnessed the slow dissolution of this thread, the outlines of which, gradually losing their distinctness at the same time throughout the whole length of the thread, finally disappeared completely at the same time that the pseudopodium became Amœboid. Perhaps we have here only what may be called a voluntary and facultative hardening of the axis of the pseudopodium, resembling what takes place at the surface of the body of the Amœbæ and other Protozoa in which the ectosarc is viscous or, on the contrary, resistant and non-glutinous at will.

The pseudopodia in their entirety present very interesting phenomena; at one moment rigid and elastic, like steel wires, they will become all at once soft and indifferent, without, however, always changing their form; exposed to a shock (produced, for example, by a violent stream of water), they will retract themselves suddenly into a single mass, to push out again in a few minutes and attain a length double that of the body. The pseudopodia of *Actinosphærium*, shorter relatively to the diameter of the animal, are absolutely similar to those of *Actinophrys*, as indeed is the case with the whole animal, which differs so little from the latter, that I have often been tempted to derive it from a simple colony of *Actinophrys*, but a colony fixed as such in the sequence of generations and resembling the colonial Radiolaria.

As to the pseudopodia of the *Acanthocystides*, they are distinguished from those which we have just been considering by a much more considerable fineness and at the same time by a much greater comparative length. They are composed of a rigid thread, upon which are sprinkled small granules of grey plasma, united to each other no doubt by a sort of protoplasmic varnish. The granules, with the varnish, would then represent the greyish covering of the pseudopodia of *Actino-*

phrys. As to the rigid threads, they have been seen to traverse the body of the animal and to converge towards a common centre, where there was a central granule brightly stained by carmine.

In other respects the pseudopodia of the *Acanthocystides* present the same phenomena as those of *Actinophrys*; they are rigid or soft according to circumstances, and they retract suddenly upon themselves during the passage of a stream of water, forming globules like those of a thread of glass exposed to a flame.

It is by means of these long pseudopodia that the Heliozoa move upon the mud or run over aquatic plants. The Actinophrydians, however, most frequently appear motionless; but sometimes, for example when a colony breaks up, the individuals are animated by a perceptible movement; we then see that they pull upon their anterior pseudopodia, the points of which they have stuck to the soil, while the posterior ones drag behind, become elongated by traction, and finish by detaching themselves and shortening. The lateral pseudopodia, also fixed to the soil by their points, likewise drag a little behind, so that from the general appearance of the animal we can foresee the point at which it will finally arrive.

As to the *Acanthocystides*, the movements of which are sometimes so rapid that they traverse in one minute a course equal to ten or twelve times their diameter, I have succeeded after a very careful examination in explaining them in the following manner:—The animal, resting on its pseudopodia like a cursorial spider upon its legs, throws out in front some of these pseudopodia; these attach themselves to the soil by their points, which are at the moment viscous and perhaps also slightly dilated into heads; then, stiffening, they draw the animal towards them; the body, while advancing slightly, turns a little upon itself from behind forwards, probably because the cords or pseudopodia which drag it originate above the equator of the animal; new pseudopodia, always antero-superior, then attach themselves by their points in front of the former ones and stiffen in their turn. This movement continuing and the anterior cords pulling while the posterior ones detach themselves one after the other, often with a small sudden shock, and the lateral ones seeming to steady the whole, the animal progresses by rolling continually over and over, so that, by transmitted light, we see all the excentric elements, prey or granules, contained within the body traverse this body in a straight line, at first from behind forward and then from in front backwards. It must be remarked that during locomotion the body appears to turn much too slowly relatively to the distance travelled—that is to say that, instead of traversing a space equal to about three times its diameter in a complete turn, it is not until after executing a much longer passage that a complete revolution has been made; this is because the sphere which may be imagined as circumscribing the animal is not represented by the body itself, but rather by the extremities of the pseudopodia.

Such, according to my observations, is the process of locomotion in the Heliozoa; and this explanation would confirm the opinion of Hertwig and Lesser, who, in a memoir, of which, however, I had no knowledge until long after arriving at my own conclusions, have described a Heliozoon as "rolling after the fashion of a ball and by the contraction of the pseudopodia."

The pseudopodia of the Heliozoa, besides their functions as locomotive organs, also play a certain part in the capture of prey. In *Actinophrys* the little organisms which have fallen among the pseudopodia as into a spider's web glide along these threads until they arrive quite close to the body, at the same time that a portion of plasma issuing from the ectosarc advances to meet them, encloses them, and keeps them for whole hours in a large vacuole full of liquid, in which they are digested. The pseudopodia themselves may be active in so far that they bend round the captured prey and draw it on; but this fact, although certain, is much more rare than is generally supposed.

In the *Acanthocystides* the phenomenon of the capture of prey is still more interesting, and is at present known only in its broad features. After having studied it in half a dozen species I can describe it as follows, again taking *Acanthocystis turfacea* as an example.

When a small organism, such as a Monad for example, comes in its course in contact with an *Acanthocystis*, the radial spicules of the latter separate and lie down, at the same time that a depression is formed at the spot upon which the prey has fallen; the bases of the spicules then change their position, moving in the very body of the mucilaginous layer which bears them, and gain the margins of the depression, where the spicules are soon seen accumulated in disorder; the tangential scales do the same, and the whole mucilaginous mass separates, thus leaving an opening in which the prey finally comes into direct contact with the interior body or so-called ectosarc of the *Acanthocystis*. At this moment the withdrawn mucilage begins to show an active movement all round the Monad, and finally englobes it completely; the spicules ascend on their part, and the tangential scales, conpletely immersed in the mucilage, arrive at the top before the radial spicules, although after the complete closure of the mucilaginous arch. It is very interesting to see the scales advance, one after the other, in this hyaline envelope, in which they seem to swim, as it were in midwater, as if by a movement proper to them; the radial spicules, having their base only immersed in this envelope, appear to have more resistance to overcome and arrive at the top more slowly; nevertheless they reach it, and, after a moment of confusion, resume their relative positions, and the *Acanthocystis* is then again completely covered by its coat of mail, and an observer coming upon it at this moment might wonder by what means so large a prey could have penetrated beneath the membrane. The whole phenomenon scarcely lasts more than a minute.

As to the kind of nourishment of the Heliozoa, this is variable according to the medium; we see some which are stuffed with microscopic Algæ, Diatomeæ, Desmidieæ, &c.; but in general they seem to prefer to capture small animals, Monads, Vorticellæ, Rotifera, &c. *Actinophrys*, in particular, consumes an incredible number of the latter, and does not always capture them without trouble.

There is much more to be said upon the physiology and constitution of the Heliozoa. I have not mentioned the bodies of different nature contained in the internal plasma, such as grains of starch, chlorophyll, &c., nor the phenomena of multiplication (fission, conjugation, budding, spores), nor the siliceous cysts into which the animals withdraw, nor the colonies which certain species like to form. All this would lead us rather too far *. I prefer at present to add a few words upon certain organisms which may show us points of approximation between the Heliozoa on the one hand and the Monera, Amœbæ, and even the Flagellata on the other.

The first of these organisms is *Vampyrella spirogyræ* of Cienkowski. Häckel has classed the *Vampyrellæ* among the Monera, or Rhizopods destitute alike of nucleus and of contractile vesicle; of late, indeed, very numerous grains of chromatine or of nuclear substance have been discovered in several organisms which had previously passed as devoid of nucleus;

* I would nevertheless revert to certain very brilliant blue grains, sometimes very large, enclosed within the body of the *Acanthocystides*, the signification of which I have discussed in the second part of my memoir on the Heliozoa (Arch. de Biologie, tome ix.). For some time I have come to the conclusion that we had to do here simply with grains of starch. Now, a few days ago, having opened a glycerine-preparation in which I preserved one of these large grains, I treated the latter with iodine, and saw it immediately acquire a fine violet colour. It is therefore starch, and my first suppositions were erroneous.

and in some individual *Vampyrellæ* it appears that Zopf has found a true nucleus. But Häckel's classification still retains a great systematic value. As regards the *Vampyrellæ*, I do not know whether the authors who have made them Heliozoa (*e. g.* Bütschli, in his fine work on the Protozoa) have not attached too great importance to mere external resemblances.

Vampyrella spirogyræ, in its normal state, is a small Rhizopod of about 40 micromillimetres in diameter, spherical, of a fine brick-red colour, devoid of nucleus and contractile vesicle, but containing in its ectosarc a great quantity of small non-contractile vacuoles. From the exterior radiate a considerable number of pseudopodia, some long and covered with granules, the others very short and as if terminated by pins' heads, the last appearance being due to the fact that, especially when the animal is progressing, very small hyaline spheres run constantly over these pseudopodia, seeming positively to be thrown out by the animal and to fall again immediately at the very point from which they were expelled. The phenomenon of these little balls springing up on all sides is so extraordinary that when I had this species under my eyes for the first time I thought I could not do better than name it provisionally the "*Vampirelle jongleuse*;" subsequently I found that it had been described and even bore two names—*Vampyrella lateritia* in consequence of its colour, and *Vampyrella spirogyræ*, after the plant from which it prefers to obtain its nourishment.

It is upon the manner in which this species acts in order to empty the cells of the *Spirogyræ* that I wish to say a few words here; in fact my observations have led me to an explanation different from that usually given. The *Vampyrella* is said to pierce a hole in a cell of *Spirogyra* and to introduce into it a pseudopodium, the business of which is to search the contents of the cell. For my part this is how I can describe the phenomenon which I have observed repeatedly, always arriving at the same conclusions:—The *Vampyrella* attaches itself to a cell of *Spirogyra*, retracts its pseudopodia, except a few by which it adheres to the Alga, and then moulds itself to the cell upon a portion of its surface, and becomes motionless. For a moment nothing takes place; then we see the attached zone rise up into an arch in the interior, the margins remaining firmly attached and formed into a ring; the arch gradually rises, and suddenly the wall of the Alga bursts, the cell-juice of the *Spirogyra* passes in a violent stream into the *Vampyrella*; the greyish plasma of the cell passes in its turn more slowly, with the green chromatophore, which is seen to glide in a mass; the cell is completely emptied, the *Vampyrella* emits pseudopodia, becomes detached, and moves away, leaving a very visible rupture in the empty cell. It then often goes to the next cell, or even to a third, and, having emptied these in the same manner and become greatly enlarged, it encysts itself. At this moment it has lost its brick-red tint, which is at the utmost visible here and there in spots in the greenish mass with which its body is stuffed. Later on it will divide within its cyst into several embryos, which will pierce a hole and issue one after the other, already clothed in their fine red colour.

To return to the nutrition of the *Vampyrella*: this is effected, in my opinion, by a true phenomenon of suction, the whole body of the animal acting as a sucking-cup; what would seem to be opposed to this view is that the cell of the Alga as it is emptied does not flatten under the pressure of the surrounding liquid; but it is possible that the cell, as it loses its original contents, gets filled with water through the partition which separates it from the following cell, or even through the whole of its own wall.

Another organism to which I wish to call attention is a new form of Heliozoon which I have met with this summer in considerable abundance, but only on one occasion. The body, which is very small (about 15 micros) and of a reddish tint, is normally spherical, but is subject to very rapid deformations of considerable amount, though always tolerably thickset and retaining its distinct outline; the ectosarc, a thin lighter band, is traversed by a line of very small tangential spicules, but has no radiating ones; the pseudopodia, which are hyaline, sparingly granular, excessively long, filiform, and thicker at the base than at the apex, are in very small number. The animal runs like a spider by means of its pseudopodia, leaping to one side or straight forward with surprising agility, so that it progresses almost as rapidly as a Flagellate. It has sometimes appeared to me even to swim freely in the water, and can at any rate beat with its pseudopodia, which, however, have nothing to do with real flagella. This organism possesses an excentric nucleus in a clear endosarc, and a contractile vesicle. There is no doubt that it is a true Heliozoon, which resembles some *Amœbæ* in the plasticity of its body and in the nature and restricted number of its pseudopodia (*Amœba radiosa*).

Lastly, I have a few words to say upon another organism which I also found in abundance this summer at Wiesbaden, but only in a single locality. It is a true Monad, spherical, of small size (10–15 micros), with two very clear flagella which I have often seen beating and drawing food into a depression or mouth opening near their base. But what distinguishes this Protozoon from the Flagellata in general is the possession of numerous filiform, rigid, straight pseudopodia covered with granulations, in fact similar to those of the *Acanthocystides*, and by means of which the animal attaches itself to the ground and moves slowly. This organism is furnished with a central nucleus and a contractile vesicle, and can feed equally by the whole of its surface, after the fashion of the Heliozoa. Although this Protistan must be regarded as a Flagellate, it seemed to me to be of interest to mention it here, as it appears to have acquired certain elements characteristic of a very different group of Protozoa.

XIX.—*Description of a new Species of* Sorex *from Saghalien Island.* By G. E. Dobson, M.A., F.R.S.

The following description of the largest species of the genus *Sorex* as yet known to inhabit the Eastern Hemisphere is derived from an examination of four specimens, two adult females preserved in alcohol and two skins with skulls, which form part of the collection of the Zoological Museum of the Imperial Academy of Sciences at St. Petersburg.

Sorex unguiculatus.

Larger than *Sorex alpinus*, but with a considerably shorter tail, and distinguished from every known species of the genus by the extraordinarily large size of the manus and its claws, which have their parallel only in *Crocidura macropus*. In the shape of the head, body, and tail this species resembles *S. vulgaris*; the tail is clothed evenly with short, rather stiff hairs, which do not form a pencil at the extremity; the fur is dark brown above, on the under surface the extremities of the hairs are ashy; the dorsal surface of the manus is clothed with a few short, shining, grey hairs, but the digits are naked and the rings of integument are divided into tubercles, not entire as in *S. vulgaris*.

The manus and pes are very large, especially the former, which greatly exceeds that of *S. vulgaris* both in breadth and in length, the claws of the three middle digits being nearly as long as the digits without claws; on the other hand those of the digits of the pes are not unusually large.

The skull differs altogether from that of *S. vulgaris* in its